

# Y8950

## (MSX-AUDIO)

### ■ OUTLINE

The MSX-AUDIO is a sound generator LSI developed as optional sound source for the MSX2 personal computer. To create realistic, exciting sounds, the MSX-AUDIO incorporates an FM sound generator, similar to that previously used in Yamaha Electones and the DX-7 synthesizer. This product also has ADPCM speech analysis/synthesis functions in addition to the composite sinusoidal modeling function of conventional FM sound generators.

This new function allows simplified sound data processing.

Either of the AD/DA converters built in the analysis/synthesis circuit can be used independently to process even analog data.

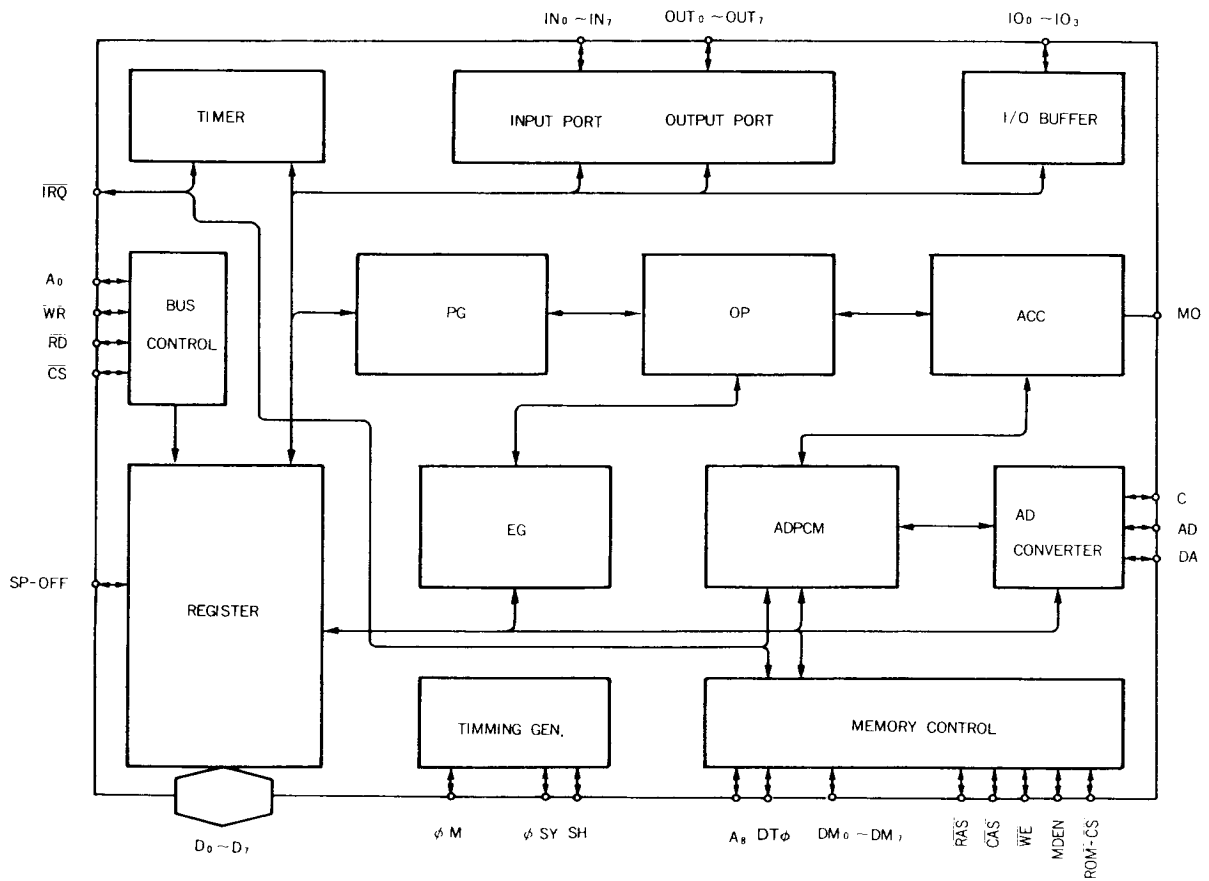
The MSX-AUDIO is equipped with input/output ports for a keyboard interface, as well as general-purpose input/output ports.

Consequently, one MSX-AUDIO unit allows you to perform a variety of data processing for sound production.

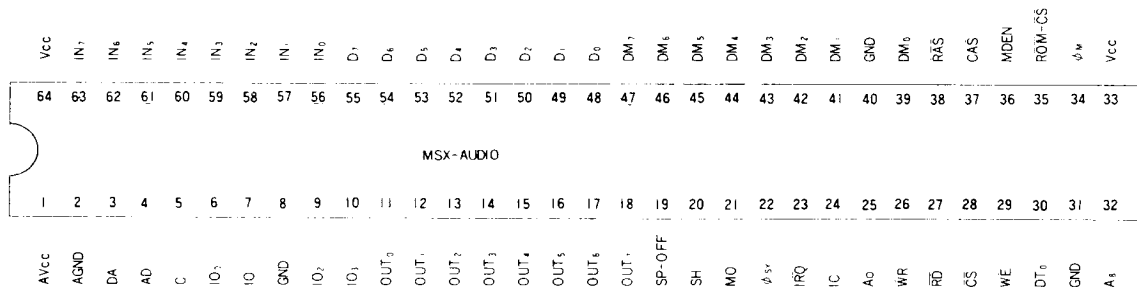
### ■ FEATURES

- Realistic sound due to FM sound generator. The FM sound generator is compatible with the YM3526.
- Selection of two sound-generation modes: simultaneous sounding of nine tones or six melodies and five rhythms (compatible with the Character and Pattern Telephone Access Information Network system and Teletex)
- The vibrato and AM oscillators are built in.
- 4-bits ADPCM speech analysis/synthesis circuits are built-in.
- AD/DA converters are built in.
- External 256-Kbytes memory (ROM or RAM) can be connected (as ADPCM data storage or auxiliary CPU storage)
- 8-bits input/output ports are built in for keyboard scanning.
- Two built-in general-purpose timers
- TTL compatible input/output
- Si-gate CMOS LSI
- 5V single power supply

1. BLOCK DIAGRAM



2. PIN LAYOUT



## 3. DESCRIPTION OF TERMINAL FUNCTIONS

Pin No.	Signature	Description																														
1 33, 64	AVcc Vcc	+5V power terminal																														
2 8,31,40	AGND GND	Ground terminal																														
3 4 5	DA AD C	Terminal for AD conversion, DA connects DAC output (reference data). AD is an analog input terminal and it is AD convertible within the range of $V_{cc}/2 \pm V_{cc}/4$ . C terminal is a capacity terminal to samplehold analog data.																														
6, 7 9, 10	$\overline{IO}_0 \sim \overline{IO}_2$	General purpose IO ports.																														
11 ~ 18 56 ~ 63	OUT <sub>0</sub> ~ OUT <sub>7</sub> IN <sub>0</sub> ~ IN <sub>7</sub>	Input ports (IN <sub>0</sub> ~ IN <sub>7</sub> ) and output ports (OUT <sub>0</sub> ~ OUT <sub>7</sub> ) for keyboard scanning. Input ports are pulled up and output ports are open drain type.																														
19	SP-OFF	At AD conversion, DA converter is used as a reference voltage generator. For that, the amplifier and speaker must be disconnected and this terminal is a control terminal to be used then.																														
20 21 22	SH MO $\phi$ SY	MO is sound/speech output of MSX-AUDIO. As this output is 13 bits (Mantissa 10 bits, exponent 3 bits) serial data, it must be converted into analog value by means of $\phi$ SY synchronous clock, SH synchronizing signal and DA converter (YM3014).																														
23	IRQ	Interrupt signal output from two timers and ADPCM/memory control. Maskable depending on program.																														
24	IC	Initializes MSX-AUDIO operation.																														
25 26 27 28	A <sub>0</sub> WR RD CS	Controls D <sub>0</sub> ~ D <sub>7</sub> data bus. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>CS</th> <th>RD</th> <th>WR</th> <th>A<sub>0</sub></th> <th></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>Writes MSX-AUDIO address.</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>Writes MSX-AUDIO register contents.</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>Reads MSX-AUDIO status.</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>Reads MSX-AUDIO register contents. (specific register only)</td> </tr> <tr> <td>1</td> <td>×</td> <td>×</td> <td>×</td> <td>D<sub>0</sub> ~ D<sub>7</sub> bus line becomes high impedance.</td> </tr> </tbody> </table>	CS	RD	WR	A <sub>0</sub>		0	1	0	0	Writes MSX-AUDIO address.	0	1	0	1	Writes MSX-AUDIO register contents.	0	0	1	0	Reads MSX-AUDIO status.	0	0	1	1	Reads MSX-AUDIO register contents. (specific register only)	1	×	×	×	D <sub>0</sub> ~ D <sub>7</sub> bus line becomes high impedance.
CS	RD	WR	A <sub>0</sub>																													
0	1	0	0	Writes MSX-AUDIO address.																												
0	1	0	1	Writes MSX-AUDIO register contents.																												
0	0	1	0	Reads MSX-AUDIO status.																												
0	0	1	1	Reads MSX-AUDIO register contents. (specific register only)																												
1	×	×	×	D <sub>0</sub> ~ D <sub>7</sub> bus line becomes high impedance.																												
29 37 38	$\overline{WE}$ CAS RAS	Control signal of the external memory. When the external memory is DRAM, it is connected to the terminal to which RAM corresponds and it becomes address latch signal (RAS-CAS) when the external memory is ROM.																														
30 32	DT <sub>0</sub> A <sub>8</sub>	A <sub>8</sub> is an external memory address (A <sub>8</sub> ) and DT <sub>0</sub> is likewise data out (DO <sub>0</sub> ).																														
34	$\phi$ M	MSX-AUDIO master clock, with 3.57954 MHz as a standard.																														
35 36	$\overline{ROM-CS}$ MDEN	Applies timing to take in the external memory data. When MDEN is "1", it allows DRAM data on DM <sub>1</sub> ~ DM <sub>7</sub> and when ROM-CS is "0", it allows ROM data on DM <sub>1</sub> ~ DM <sub>7</sub> . (Data out 0 on DT <sub>0</sub> )																														
41 ~ 47	DM <sub>0</sub> ~ DM <sub>7</sub>	Multiplexes the external memory address (A <sub>0</sub> ~ A <sub>7</sub> ), data IN (DI <sub>0</sub> ~ DI <sub>7</sub> ) and data out (DO <sub>1</sub> ~ DO <sub>7</sub> : DO <sub>0</sub> are different terminals) signals to each terminal of DM <sub>0</sub> ~ DM <sub>7</sub> .																														
56 ~ 63	D <sub>0</sub> ~ D <sub>7</sub>	8 bits bi-directional data bus. Transmits and receives data with the processor.																														

## 4. ELECTRIC CHARACTERISTICS

### (1) Absolute Maximum Rating

Item	Rated value	Unit
Terminal voltage	-0.3 ~ 7.0	V
Operating ambient temperature	0 ~ 70	°C
Storage temperature	-50 ~ 125	°C

### (2) Recommended Operating Conditions

Item	Symbol	Minimum	Typical	Maximum	Unit
Power voltage	V <sub>CC</sub>	4.75	5.0	5.25	V
	V <sub>SS</sub>	0	0	0	V

### (3) DC Characteristics

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Input high-level voltage	Input except for IN0 ~ 7	V <sub>IH1</sub>	2.0			V
	IN0 ~ 7	V <sub>IH2</sub>	3.5			V
Input low-level voltage	Input except for IN0 ~ 7	V <sub>IL1</sub>			0.8	V
	IN0 ~ 7	V <sub>IL2</sub>			1.2	V
Input leak current	A <sub>0</sub> , $\overline{WR}$ , $\overline{RD}$ , DTO	I <sub>IL</sub>	V <sub>IN</sub> = 0 ~ 5V	-10	10	μA
Three-state (offset-state) input current	D <sub>0</sub> ~ D <sub>7</sub> , DM <sub>0</sub> ~ DM <sub>7</sub> IO <sub>0</sub> ~ IO <sub>3</sub>	I <sub>ISL</sub>	V <sub>IN</sub> = 0 ~ 5V	-10	10	μA
Output high-level voltage	Output except for $\overline{IRQ}$ , OUT0-7	V <sub>OHI1</sub>	I <sub>OHI1</sub> = 0.4mA	2.4		V
		V <sub>OHI2</sub>	I <sub>OHI2</sub> = 40μA	3.3		V
Output low-level voltage	All output	V <sub>OOL</sub>	I <sub>OOL</sub> = 2mA		0.4	V
Output leak current (offset state)	$\overline{IRQ}$ , OUT0-7	I <sub>OIL</sub>	V <sub>O</sub> = 0 ~ 5V	-10	10	μA
Analog input voltage	AD, DA	V <sub>A</sub>		V <sub>CC</sub> /4	3V <sub>CC</sub> /4	V
Pull-up resistor	$\overline{IC}$ , $\overline{IRQ}$	R <sub>P1</sub>		60	600	KΩ
	IN0-7	R <sub>P2</sub>		5	10	KΩ
Input capacity	All input	C <sub>IN</sub>	f = 1MHz		10	pF
Output capacity	All output	C <sub>O</sub>	f = 1MHz		10	pF
Power supply current		I <sub>CC</sub>			70	mA

## (4) AC Characteristics

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit	
Input clock frequency	$\phi M$	fc	A-1	3	3.58	4	MHz
Input clock duty	$\phi M$			40	50	60	%
Input clock rise time	$\phi M$	T <sub>CR</sub>	A-1			50	ns
Input clock fall time	$\phi M$	T <sub>CF</sub>	A-1			50	ns
Address setup time	A <sub>0</sub>	T <sub>AS</sub>	A-2, A-3	10			ns
Address hold time	A <sub>0</sub>	T <sub>AH</sub>	A-2, A-3	10			ns
Chip select write width	$\overline{CS}$	T <sub>CSW</sub>	A-2	380			ns
Chip select read width	$\overline{CS}$	T <sub>CSR</sub>	A-3	380			ns
Write pulse write width	$\overline{WR}$	T <sub>WW</sub>	A-2	380			ns
Write data setup time	D <sub>0</sub> ~ D <sub>7</sub>	T <sub>WDS</sub>	A-2	10			ns
Write data hold time	D <sub>0</sub> ~ D <sub>7</sub>	T <sub>WDH</sub>	A-2	30			ns
Read pulse width	$\overline{RD}$	T <sub>RW</sub>	A-3	380			ns
Read data access time	D <sub>0</sub> ~ D <sub>7</sub>	T <sub>ACC</sub>	A-3			380	ns
Read data hold time	D <sub>0</sub> ~ D <sub>7</sub>	T <sub>RDH</sub>	A-3	10			ns
Output port fall time	OUT <sub>0</sub> ~ 7	T <sub>OFF</sub>	C <sub>L</sub> = 500pF (Note)	20			μs
Memory data set time	DM <sub>1-7</sub> , DT <sub>0</sub>	T <sub>MDS</sub>	A-6	70			ns
Memory data hold time	DM <sub>1-7</sub> , DT <sub>0</sub>	T <sub>MdH</sub>	A-6	10			ns
Output rise time	DM <sub>0-7</sub> , $\overline{RAS}$ , $\overline{CAS}$ , $\overline{WE}$ , A <sub>8</sub> , MDEN, ROM-CS, $\phi_{SY}$	T <sub>OR1</sub>	A-4			100	ns
	SH, MO	T <sub>OR2</sub>	A-4			150	ns
Output fall time	DM <sub>0-7</sub> , $\overline{RAS}$ , $\overline{CAS}$ , $\overline{WE}$ , A <sub>8</sub> , MDEN, ROM-CS, $\phi_{SY}$	T <sub>OF1</sub>	A-4			100	ns
	SH, MO	T <sub>OF2</sub>	A-4			150	ns
Reset pulse width	$\overline{IC}$	N <sub>IC</sub>	A-5	80			cycle

(Note)

A time period from when the output request was issued through the output ports until the output port voltage becomes 1.0 V.

## 5. MAJOR FEATURES

The MSX-AUDIO has such major operating features as the FM sound generator, ADPCM speech analysis/synthesis, external memory control, AD/DA converters and input/output ports for keyboard scanning.

### (a) FM sound generator

The FM sound generator has three sounding modes: simultaneous generation of nine tones, generation of six melodies and five rhythms, and composite sinusoidal modeling. One of the three modes is selected by software according to the application. Because this FM sound generator is equivalent to that of the OPL (YM3526), the software for the OPL can be used with the MSX-AUDIO.

#### • Simultaneous nine-tone generation:

This mode simultaneously generates nine FM sounds of FM sounds of different tone colors. Both the rhythm selection bit (R) and composite sinusoidal modeling bit (CSM) should be specified with "0" for this mode.

#### • Six-melodies/five-rhythms sounding:

This five available rhythmic sounds are bass drum, snare drum, tom-tom, high-hat cymbals, and top cymbal.

#### • Composite sinusoidal modeling:

This is a speech synthesis mode to simulate sounds by using three to six sine waves.

### (b) ADPCM speech analysis/synthesis

This function provides the speech analysis and synthesis using 4-bits ADPCM. The sampling rate for modulation can be arbitrarily programmed within 1.8 KHz—16 KHz (analysis) and 1.8 KHz—50 KHz (synthesis). Analysis results and synthesis data can be stored in either external memory (ROM or RAM) or the processor's storage.

### (c) External-memory control

This function controls the external memory used to store the anylysis/synthesis data processed through ADPCM. Available external memories are 256 K-bytes DRAM, 64 K-bytes DRAM, and the ROMs accessible in units of byte. The maximum storage capacity is 256 K-bytes (both RAM and ROM).

### (d) AD/DA converters

The AD/DA converers in the ADPCM unit can be operated independently.

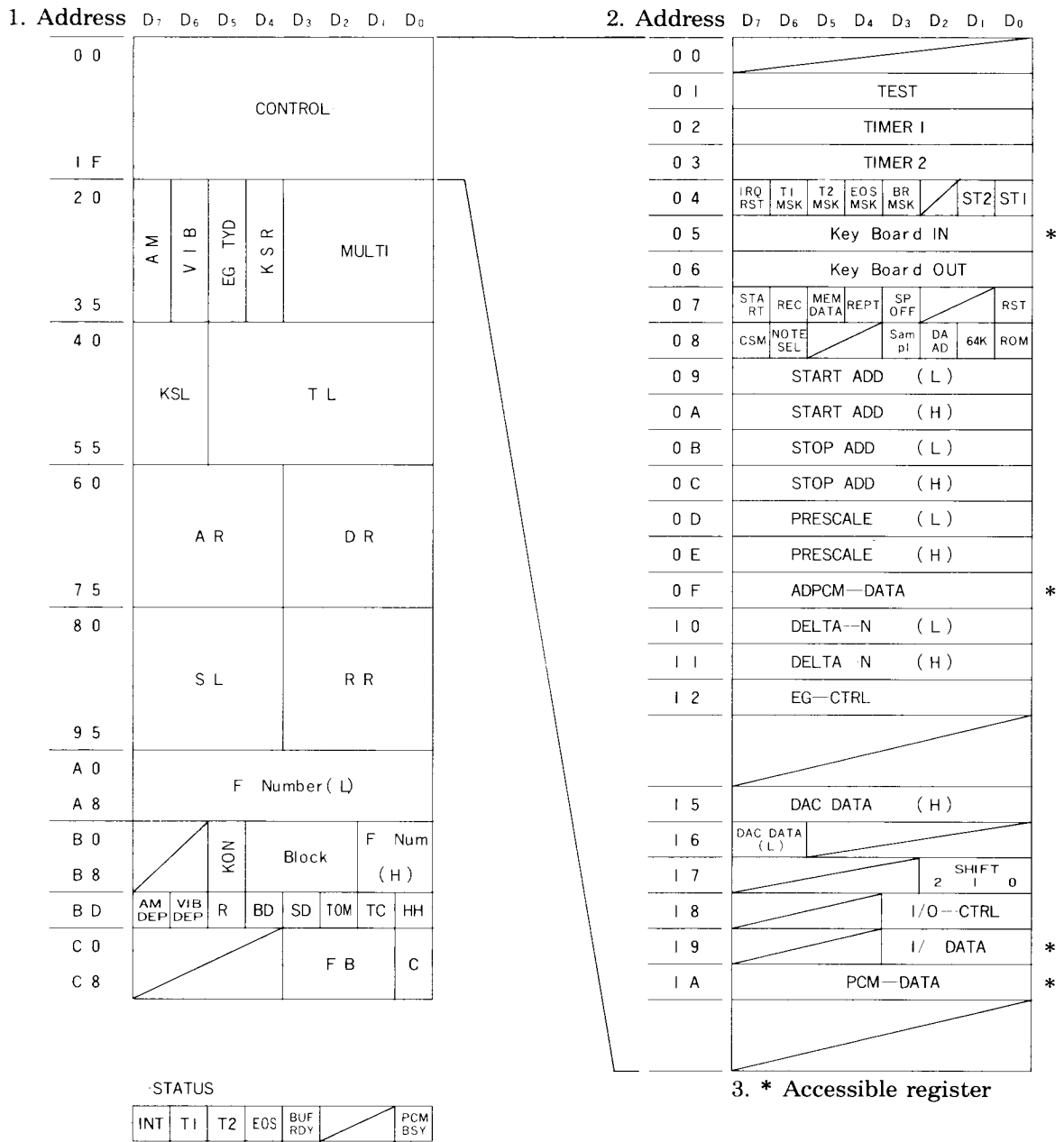
In this AD/DA conversion mode, FM sound generation and ADPCM speech analysis/synthesis are ineffective.

### (e) Keyboard input/output ports

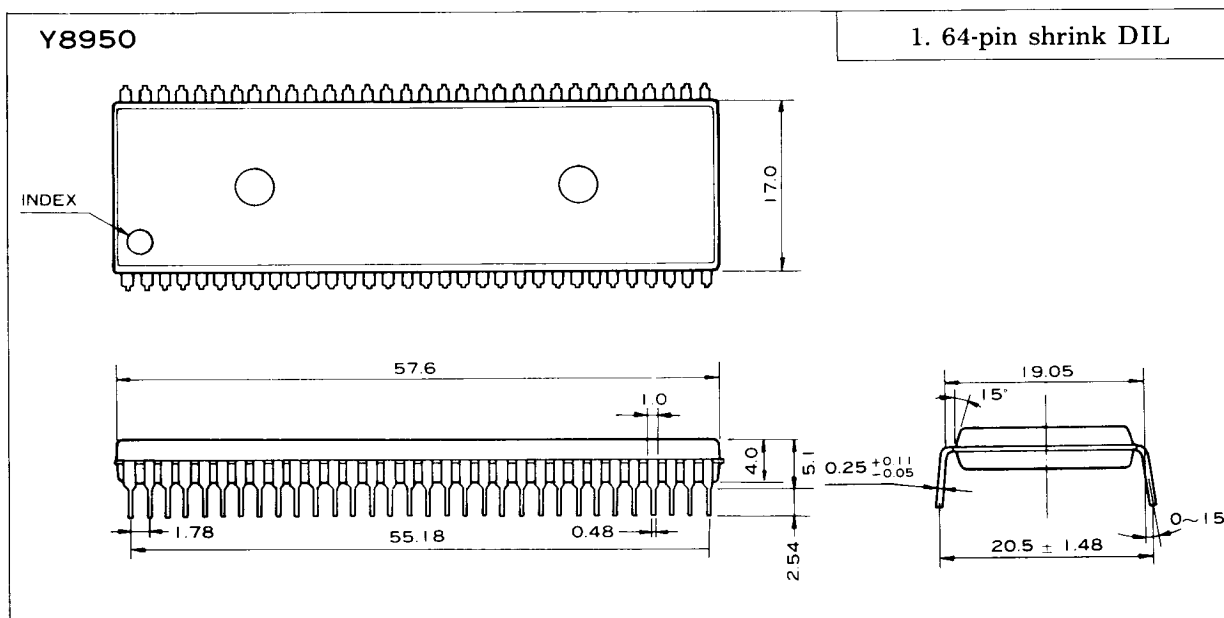
These are 8-bit input/output ports for external keyboard scanning.

In addition to the above-mentioned functions, the MSX-AUDIO is equipped with vibrato and amplitude-modulation oscillators for further natural sound generation, two general-purpose timers for various interface signals, and general-purpose 4-bits input/output ports.

## 6. ADDRESS MAP



## PACKAGE DIMENSIONS



(Note) Specifications of this product are subject to change for purpose of improvement without prior notice.

The specifications of this product are subject to improvement changes without prior notice.

\_\_\_\_\_ AGENCY \_\_\_\_\_

### NIPPON GAKKI CO., LTD.

Address inquiries to:  
Electronic System Division

- Toyooka Factory 203, Matsunokijima, Toyooka-mura, Iwata-gun, Shizuoka-ken, 438-01 Electronic Equipment business section Tel. 053962-3125
- Tokyo Office 3-4, Surugadai Kanda, Chiyoda-ku, Tokyo, 104 Ryumeikan Bldg. 4F Tel. 03-255-4481
- Osaka Office 1-6 Shin-ashiya shita, Suita-city, Osaka-fu. 565 Tel. 06-877-4481